

ever, agrees very well with the heaven. Therefore, if the original entries of the Greenwich Observatory do not state expressly that the star was brighter than tenth magnitude on April 15, 1857, there seems to be no reason for supposing it a variable star.

*Pulkowa, 1880, May 12.*

*Coincidence of Sun-spots and Auroræ in Olden Time.*  
By the Rev. S. J. Johnson.

As with a slowly increasing number of Sun-spots at the present time we may assume the return of fine auroral displays to be drawing near, it may not be devoid of interest to examine what coincidence may be traced between the auroræ seen in this land by our forefathers and the few recorded instances we have of Sun-spots in early times. Meagre though our data may be, it is by no means difficult to trace this coincidence. The ease with which this may be done is more remarkable from the fact that, according to Wolf's tables, there are instances laid down of sixteen years between the assumed maxima of solar spots, and at other times less than half this period.

In a communication to *Nature*, January 13, 1870, an endeavour was made to show that the epochs at which Sun-spots were seen before the invention of the telescope were coincident with the maximum periods of the Sun-spot cycle. Thus it was remarked—

From 321	A.D. to 1860	we have 139 periods of 11·072 + years each			
„ 321	„ 807	„ 44	„ 11·045	„	
„ 807·22	„ 840·5	„ 3	„ 11·093	„	
„ 840·5	„ 1096	„ 23	„ 11·109	„	
„ 1096	„ 1161	„ 6	„ 10·833	„	

But a great number of spots are on record, chiefly in China, as seen with the naked eye, in addition to those mentioned in the said article.

The first instance in our own country occurs less than twenty years after the first recorded eclipse, being the mention by Matthew of Westminster of “fiery lances in the air,” in the year 555. The Chinese do not record spots close to this date, but in 577, which would give two periods of eleven years each.

The following instances will be found in the *Chronicon Scotorum* and the *Anglo-Saxon Chronicle*.

A.D. 660. “In the summer, the sky was seen to burn.” *Chronicon Scotorum*.  
Employing the data above referred to, it will be seen that from 660

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to 807 there are thirteen periods of about  $11\frac{1}{3}$  years each. The following evidently occurred about the time of the next Sun-spot maximum.

670. "A thin and tremulous cloud in the form of a rainbow appeared at the fourth watch of the night of the fifth day before Easter Sunday (stretching) from east to west in a clear sky. The moon was turned into blood." *Chron. Scot.* The expression "clear sky" may be understood comparatively as it is now generally assumed that the aurora is hardly ever visible in a perfectly clear sky, and often appears mingling with cirrous haze. On one occasion only, I observed an aurora when not a trace of cloud was perceptible. In the instance of A.D. 670, the auroral arch appears to have been very marked, as we witnessed in 1869, 1870, and 1872. The expression concerning the Moon in other parts of the early chronicles, always indicates a total eclipse. On this occasion, however, there was no eclipse, but the Moon must have appeared suffused with the auroral vapour. It is worthy of note that on March 19, 1848, when the Moon shone with such vivid redness during the total phase, though deeply immersed in the shadow of the earth, instead of the ordinary dull copper tint, an aurora was prevailing.
710. "A bright night in autumn," *Chron. Scot.* This somewhat obscure expression seems best explained by an aurora; and if so, would happen four ten-year periods after the luminous arc of 670.
773. "In this year a red cross appeared in the heavens after sunset." *Angl.-Sax. Chron.* It is probable an auroral light is referred to here. The interval, from 773 to 807, when spots were particularly noted, gives three periods of  $11\frac{1}{3}$  years each.
793. "In this year, dire forewarnings came over the land of the Northumbrians, and miserably terrified the people; there were excessive whirlwinds and lightnings, and fiery dragons were seen flying in the air." *Sax. Chron.* The "fiery dragons" may give the idea of red auroral streamers. But this would not synchronise with an assumed Sun-spot maximum, and may be best explained by a meteoric display.
890. "The heavens appeared to be on fire at night on the Kalends of January." *Chron. Scot.* There would be five ten-year periods from 840, when Sun-spots were often noticed during the summer months. As the intervals are periods of ten years, not of half or two-thirds of that number, we may regard the coincidence as quite satisfactory, though eleven years is generally assumed as the average Sun-spot interval. Again, conspicuous auroræ are noticed a year or two at least on each side of the maximum time.
944. "Two fiery columns were seen a week before Allhallowtide which illuminated the whole world." *Chron. Scot.* We have here ten average periods of  $10\cdot4$  years from 840.
979. "A bloody cloud in likeness of fire was seen oftentimes; and that was most apparent at midnight, and was coloured in various rays. Then, when it was about to dawn, it glided away." *Sax. Chron.* We may suppose either twelve average periods of  $11\cdot6$  years, or thirteen of  $10\cdot7$  years after 840.
1098. "Before S. Michael's Mass the heaven appeared almost all night as if it were burning." *Sax. Chron.* Two years before this, solar spots were seen with the naked eye. It would, therefore, happen not long after a Sun-spot maximum.

1117. "In the night of the XVIIth of the Kal. of January (Dec. 16th), the heaven was seen very red, as if it were a conflagration." *Sax. Chron.* The interval from 1096 gives two periods of 10·5 years, and in the following year, 1118, the Chinese record Sun-spots.

1122. "There were many shipmen on the sea, and on (fresh) water, who said that they saw in the north-east a great and broad fire near the earth, which at once waxed, in length, up to the sky, and the sky separated into four parts, and fought against it, as if it would quench it; but the fire nevertheless waxed up to the heavens. The fire they saw in the dawn, and it lasted so long till it was light over all. That was on the day the VIIth of the Ides of December (Dec. 7th)." *Sax. Chron.* The account reminds one of Stowe's description of a fine aurora in the time of Queen Elizabeth. It was but a short interval from the last display in 1117, but the Chinese records speak of Sun-spots being seen the next year, in 1123. We must therefore conclude that the Sun's disc was in a very active state about this time, and according to Dr. Wolf there have been intervals of only  $7\frac{1}{2}$  years in modern times between the maxima.

1131. "This year after Christmas, on a Monday night, at the first sleep, the heaven was, on the north side, all as though it were a burning fire, so that all who saw it, were so affrighted as they never were before. That was on the IIIrd of the Ides of January (Jan. 11th)." *Sax. Chron.* An interval of nine years from the last. It will be observed that it was witnessed three ten-year periods before the spot of the Spanish Moor Averroës (1161). The Chinese have numerous records of solar spots in this century, the 12th, and also in the 4th. The *Chronicon Scotorum* and *Anglo-Saxon Chronicle* contain no mention of these phænomena.

*Abbenhall Rectory, Gloucester,*  
1880, June 9.

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*On the Refractive and Dispersive Powers of various Samples  
of Glass. By Mr. J. G. Lohse.*

(Communicated by Lord Lindsay.)

With a view to obtaining a knowledge of the refractive and dispersive powers of various sorts of glass now in actual use, the prisms have recently been examined at Dun Echt Observatory by Mr. J. G. Lohse. Prisms 1 to 8 were kindly lent by Mr. Hilger with the option of purchasing any or all of them except No. 8, which was a beautiful sample prism of an object-glass in course of construction. Nos. 9 and 10 were supplied by Mr. Grubb as closely resembling the lenses of the Dun Echt 15·06-in. refractor.

The indices of refraction are for vacuum-glass.

The specific gravities are reduced to vacuum and 0° Cent. in terms of water at its greatest density.